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ABSTRACT

This paper reports on a workshop developed to give middle school teachers experience using the TI-73 calculator as a teaching tool and to serve as a model for the introduction of technology into their classrooms. A booklet prepared for the workshop gave keystrokes used for the TI-73 with an emphasis on features that are unique to this calculator. The booklet and the workshop discussed topics of particular interest in middle grades classrooms and included projects that middle grades teachers could use in the classroom. Sections of the booklet are described. Topics featured in the workshop included fractions, graphing piecewise defined functions, integer division, curve fitting, modeling data, and graphs of equations. (MM)

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Preparing Inservice Middle Grades Teachers to Use the TI-73

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Preparing Inservice Middle Grades Teachers to Use the TI-73

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Because technology is becoming increasingly available in middle schools, it is important for inservice teachers to be able to use technology, especially graphing calculators, effectively in their classrooms. The TI-73 Graphing Calculator has features that are unique and aimed at the Middle School student. Few inservice middle grades teachers in our service areas have had contact with graphing calculators, and virtually none have used the TI-73 calculator. Thus a workshop was developed that gives these teachers experience using the TI-73 as a teaching tool, and that serves as a teaching model for the introduction of technology into their classrooms.

In the workshop middle grades teachers experienced how to make learning math interesting and fun through projects using the special features of the TI-73. We introduced the teachers to the TI-73 by first showing them some keystrokes and features that are useful in the middle grades classroom, and then had them participate in activities or projects designed to demonstrate the capabilities of the calculator. Courtesy of the Texas Instruments loan program, each teacher had a TI-73 to work through the projects that they could use in their classroom. Some of the activities that were presented illustrate how to prepare statistical description of data, how to use integer division in elementary number theory, how to use the draw and graphing capabilities to introduce analytic geometry, and how to bring several features together in one project.

In addition to the features on other graphing calculators, the TI-73 features include integer division, measurement conversion, a text editor, operations with constants, operations with fractions, simplification of fractions, keystroke conversion of fractions to and from decimals, and conversion of improper fractions to and from mixed numbers. It also has more statistical features than most other calculators; it displays pie graphs, pictographs, and enhanced histograms, and has spreadsheet capabilities. Some of the TI-73 features are designed specifically to enhance teaching of mathematical concepts. For example, it has an auto simplification mode for fractions, but it also has a manual simplification mode, which asks students to assist in the simplification process.

The goal of the workshop was to offer activities that assist inservice teachers in learning how to use the TI-73 and in using proper pedagogy as they introduce technology into their classrooms. The workshop was offered in several locations, and the TI-73 was received enthusiastically.

Of course, teachers entered the workshop with different experience levels. To keep the group working at the same pace, we encouraged each teacher with no graphing calculator experience to team up with a teacher who had experience. In order to show how the TI-73 is used, how it is different from other graphing calculators, how it is designed with the middle grades in mind, and how it can be used as a teaching tool, we prepared and presented the workshops in public school districts in our service areas in Georgia and South Carolina. The 26 page booklet prepared for the workshop gave the keystrokes used for the TI-73, with an emphasis on the features that are unique to this calculator. The booklet, and the workshop, discussed topics of particular interest in the middle grades classroom, and included projects that middle grades teachers could use in the classroom.

The topics introduced in the workshops included:

- Fractions
- Integer division
- Unit conversion
- Constants
- Text
- Graphing points and forming triangles
- Graphs of equations
- Graphing piecewise defined functions
- Solver
- Statistics
- Curve fitting
- Equations of lines
- Modeling data
- Drawing

Activities that related to TI-73 topics were discussed with that topic. All activities are from Explorations™ Series Books published by Texas Instruments (Discovering Mathematics with the TI-73: Activities for grades 5 and 6, Nast, Melissa and Discovering Mathematics with the TI-73: Activities for grades 7 and 8, Johnston, Ellen).

The number of topics and projects discussed in the workshops is so large that we cannot discuss them all in this paper, so we will limit our discussion to some of the topics that use features unique to the TI-73.

I. FRACTIONS

We can add fractions with the TI-73. Note that parentheses are needed to put more than one number in the numerator, but not in the denominator. The right arrow can be used to exit the denominator.

Example Calculate $\frac{7}{6+6}-\frac{6-2}{3+1}$.

Enter 7 b/c 6+6, press the right arrow, enter – (6-2) b/c 3+1, and press ENTER. This gives $-\frac{5}{12}$.

Note that the calculator requires parentheses in the numerator if it contains more than one term, but that it does not in the denominator. Also note that (1 b/c 12) gives $(\frac{1}{12})$, not $\left(\frac{1}{12}\right)$. Use right arrow to move to correct position.

Many operations with fractions, but not all, return fractional answers.

Decimal answers occur in cases where rational answers are not possible, and where the answer is a rational number > $\frac{1000}{1}$.

Examples b/c will not work after $\sqrt{8}$, $\sqrt{}$ will not follow b/c.

$\sqrt{(8+\frac{2}{3})}$ ENTER gives 2.943920

5000 b/c 3 gives 1666.666667, rather than a fraction.

The key $F \leftrightarrow D$ converts rational numbers less than 1000 from fractions to decimals and vice versa.

Examples $-\frac{5}{12}+\frac{3}{8}$

Enter -5 b/c 12 ,press the right arrow, enter + 3 b/c 8, and press ENTER. This gives $-\frac{1}{24}$, and $F \leftrightarrow D$ gives

-.0416666667. Pressing $F \leftrightarrow D$ again gives $-\frac{1}{24}$ again.

$\sqrt{(8+\frac{2}{3})}$ ENTER gives 2.943920, and $F \leftrightarrow D$ gives 2.943920.

1666.666667 $F \leftrightarrow D$ gives 1666.666667.

If the rational answer is > 1 and no more than 1000, the answer will be shown as a mixed number if the mode $A \cup$ b/c is chosen.

Example $\left(\frac{2}{3}\right)^{-1}$

$(2b/c\,3)x^{-1}$ ENTER gives $1\frac{1}{2}$.

Pressing the $A\frac{b}{c} \leftrightarrow \frac{d}{e}$ key converts between mixed numbers and fractions.

Example $1\frac{1}{2}$ $A\frac{b}{c} \leftrightarrow \frac{d}{e}$ ENTER gives $\frac{3}{2}$.

To enter a mixed number, enter the whole number part, then press the UNIT key. The fractional part is then entered with numerator, b/c (or the down arrow), denominator.

The calculator automatically simplifies the fractional answer if the Autosimp mode is chosen. If the Mansimp mode is chosen, an answer with $\downarrow$ means that the answer can be simplified by pressing the SIMP key or the SIMP key followed by a number that will reduce the fraction. If this does not completely reduce the fraction, the $\downarrow$ will occur again.

Example

$\frac{2}{12}+\frac{8}{24}$ ENTER gives $\downarrow\frac{12}{24}$.

SIMP 2 gives $\downarrow\frac{6}{12}$.

SIMP 6 gives $\frac{1}{2}$.

If the fraction is simplified in the Mansimp mode, the last factor used can be recalled with 2nd VARS 6 (factor).

II. MORE ON FRACTIONS

MATH, NUM, 3 gives the integer part of number or operations with numbers.

Example iPart($\frac{3}{5}+\frac{5}{3}$) gives 2 and fPart($\frac{3}{5}+\frac{5}{3}$) gives $\frac{4}{15}$.

ACTIVITY: Oliver's Method (from Discovering Mathematics with the TI-73: Activities for grades 7 and 8, by Ellen Johnston)

This activity leads the student to discover a relationship between the Greatest Common Factor and the Least Common Multiple of two numbers. The activity involves writing the two numbers as a fraction, simplifying the fraction, then multiplying the original fraction by the reciprocal of the simplified fraction. This also allows the discussion the concepts of prime factorization, relatively prime numbers, and reciprocal. These results can be compared with the results using gcd(A,B) and lcm(A,B).

III. INTEGER DIVISION

This gives an integer quotient with a remainder.

Example 19 INT ÷ 4 ENTER gives 4R3

The remainder from integer division can be found another way, with

MATH, NUM, 7: remainder(A, B) ENTER

Example MATH, NUM, 7: Remainder(12,5) ENTER gives 2.

ACTIVITY: It's Greek to Me (from Discovering Mathematics with the TI-73: Activities for grades 7 and 8, by Ellen Johnston)

This activity leads the student to understand Euclid's method to find the greatest common divisor or greatest common factor using the integer divide function on the TI-73. This method involves first dividing the larger number by the smaller number, then successfully dividing the divisor by the previous remainder until there is a remainder of 0. The last divisor will be the GCD.

ACTIVITY: A Prime Investigation with 7, 11, and 13 (from Discovering Mathematics with the TI-73: Activities for grades 7 and 8, by Ellen Johnston)

In this activity students investigate the divisibility of 7, 11, and 13, and discover the divisibility characteristics of certain six-digit numbers. The problem begins with each student writing down a three-digit number, then repeating those digits in the same order to make a six-digit number. Then, using the integer divide function on the TI-73, the student sees that the number is divisible by 7, 11, and 13. Next the student is led through justification why these numbers are divisible by 7, 11, and 13.

IV. UNIT CONVERSION

The CONVERT key is used to convert measures.

Examples 100, 2nd CONVERT, length, 1, 2, ENTER converts 100 millimeters to 10 centimeters.

60, 2nd CONVERT, Speed, 3, 1, ENTER converts 60 mph to 88 feet per second.

V. CONSTANTS

2nd SET permits the definition of constants, and CONST provides the constant on demand. Single and multiple constants can be defined.

Example To repeatedly use +2*3 and *3+2 in computations, use

2nd SET and define C1 = +2*3 and C2 = *3+2, with the Multiple mode.

To compute 40+2*3, press 40 CONSTANT C1 ENTER, getting 46.

To compute 40*3+2, press 40 CONSTANT C2 ENTER, getting 122.

VI. TEXT

Permits the writing of messages on the home screen and on graphs and the naming of LISTS, as we will see later. The bottom line of symbols are logic symbols, including AND, OR, and inequalities. The inequalities can be used to define piecewise functions.

Example To write CAT on the home screen, use 2nd TEXT, move the cursor to C, press ENTER, move the cursor to A, press ENTER, move the cursor to T, press ENTER, move the cursor to Done, press ENTER.

VII. GRAPHS

Equations can be entered in the Equation Editor (y =), as with other TI calculators. A new feature in WINDOW is Δ x, which overrides the xmin and xmax values to specify how much x changes when using TRACE. This can be used to give "friendly" windows.

Example Entering an equation (such as $y = x^2$) and pressing ZOOM 6 gives a window with values from -10 to 10, but with Δ x = .212765.... Changing Δ x to .2 changes xmin to -9.4 and xmax to 9.4, and each move to the left or right under TRACE is .2 units. Using the "friendly" window makes it much easier to discuss the relationship between points on the graph of an equation and values of the variables that satisfy the equation.

ACTIVITY: The Path of a Baseball

A baseball is hit at a point 3 feet above ground at a velocity of 100 feet per second and an angle of 45°. The path of the baseball is given by the function

$$y = -0.0032x^2 + x + 3$$

where y and x are measured in feet. Using the graph of this function and an appropriate window, determine whether the baseball will clear a 10-foot fence located 300 feet from home plate. The students use the DRAW command to draw the fence and then graph the function to see if the ball will clear the fence.

VIII. SOLVER

This feature is available in nearly the same format as the TI-83. It is different because the TI-73 does not have an alpha key.

Example To solve 95x = 100, press MATH, 6 and, if necessary, the up arrow to see EQUATION SOLVER. Entering 0 = 100 - 95x or 95x = 100 and pressing ENTER gives the equation. Moving the cursor to the variable in question and pressing ENTER gives the solution.

SOLVER can also be used to solve for a specified variable in an equation that contains more than one variable.

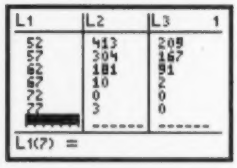
Example $F = \frac{9}{5}C + 32$ can be solved for C when F is 100 by entering the equation with the variables chosen from TEXT, entering 100 for F, moving the cursor to C, and pressing ENTER. The solution, 37.7777777777777....., can be changed to a fraction by quitting the SOLVER, entering C from TEXT, pressing ENTER, and then pressing F↔D. This gives the solution $37\frac{7}{9}$.

IX. STATISTICS

Data is entered in lists using the LIST key.

Example The table below gives the total number of prisoners executed in the U.S. from 1950 to 1979 (in groups of 5 years) and the number of black prisoners executed for the same period.

Years	(Class Mark)	Total Executions	Black Executions
1950-54	52	413	209
1955-59	57	304	167
1960-64	62	181	91
1965-69	67	10	2
1970-74	72	0	0
1975-79	77	3	0

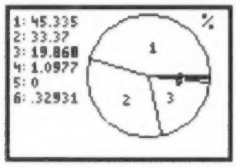


PLOT is used to compare data within a list or from two lists. Some plots are new.

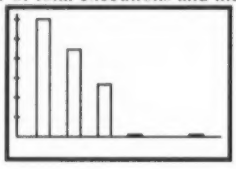
Example 2nd PLOT, 1, On turns plot 1 on.

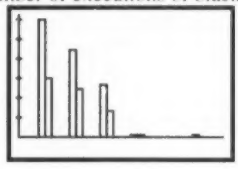
Selecting the pie chart and two lists, then pressing GRAPH gives a pieplot, with the second list giving the frequency. A listing of the points is given with the pieplot. TRACE permits us to move from value to the next.

Examples A pictoplot can also be chosen. TRACE can be used to move from one value to the next in a pictoplot. A histogram can also be chosen, and other graphs can be chosen if both lists contain numbers. The pieplot shows and gives the percent of total executions in each class, and the pictoplot shows the frequency for each class.



The first histogram shows the total number of executions and the second shows both the number of total executions and the number of executions of black prisoners.





Box plots and modified box plots are also available.

The TEXT key can be used to name lists after L6. To enter names for lists, include them in quotes, which are found in TEXT.

Example LIST, moving to the seventh list, pressing 2nd TEXT, entering "CITY", and pressing ENTER names the seventh list CITY.

ACTIVITY: Why Aren't There More Reds in My Bag? (from Discovering Mathematics with the TI-73: Activities for grades 5 and 6, by Melissa Nast)

In this activity, students use small bags of M&M's to make predictions, gather data, and display color distribution results in a circle graph.

The STAT key contains most of the same features of the TI-82 and TI-83, including mean mode, median, and standard deviation. These are found under STAT, MATH and STAT OPS.

ACTIVITY: A Penny Saved Is a Penny Earned (from Discovering Mathematics with the TI-73: Activities for grades 7 and 8, by Ellen Johnston)

In this activity the student investigates the exponential growth in powers of 2. This activity involves the age-old problem of which is the more lucrative plan. Plan A: You are given a penny the first day, 2 pennies the second day, 4 pennies the third day, 8 pennies the fourth day, and continue doubling the previous day allowance for an entire month. Plan B: You are paid a fixed amount of $1,000,000. The constant function of the TI-73 is used to constantly double the previous amount; the sequence command is used to store data into lists, a scatterplot is graphed, then the graph is investigated to determine which plan is better.

X. CURVE FITTING

The CALC feature under STAT has models for curve fitting. One new feature is the Manual Fit. The line that is the best visual fit for the points can be drawn, and its equation is shown. To draw the manual-fit line, position the cursor at the beginning of the line segment, move the cursor to match the points desired, and press ENTER. The line segment is drawn and the equation of the line is shown. Move the cursor to adjust the line, if necessary, and press ENTER.

Example To find the line that is the best fit for the points (1, 2), (4, 6), (-1, -3), and (5, 9) with Manual Fit:

1. Enter the x-coordinates in L1 and the y-coordinates in L2.

2. Pick a window that includes the points and use STAT PLOT to graph the points (like xmin -3, xmax 6, ymin -5, ymax 10, for example).

3. Using this graph, visually determine a line that is the best fit, activate STAT, CALC, Manual Fit, and move the cursor to a beginning point of this line; then press ENTER. The right side of the equation is displayed.

4. Move the cursor to a second point that determines the desired line, and press ENTER. The equation that is a close fit is $y = 1.838x - 0.6085$. Use the arrows to further adjust the line, if necessary, until it appears to be the best fit, and press ENTER.

The LinReg(ax+b) command under STAT, CALC gives y = 1.868x – 0.7033, a more accurate linear equation that fits the points. Other models under STAT, CALC can be used to fit equations to sets of points.

XI. EQUATIONS OF LINES

The Manual Fit feature under the STAT , CALC can be used to find the equation of a line passing through two points. This can be used to check the equation developed by algebraic methods. To find the equation:

1. Get a screen containing the two points that is "friendly," by setting Δ x = .2 or some other "nice" value and by setting ymax and ymin so that (ymax - ymin)/62 is "nice."

2. Enter the coordinates of the two points in L1 and L2, and use STAT PLOT to graph the points.

3. Use STAT CALC Manual Fit to get a line through the two points. The equation of this line will be displayed above the graph.

Example To find the equation of the line that passes through (1, 1) and (4, 16).

1. Set the window with xmin 0, xmax 9.4, (giving Δ x = .1), and with ymin 0, ymax 31, (giving Δ y = .5).

2. Enter 1 and 4 in L1, and enter 1 and 16 in L2. Plot the points with STAT PLOT.

3. Use STAT CALC Manual Fit to get a line through the two points.

Above the graph the display reads 5x – 4, so the equation is y = 5x – 4.

To find the equation of the line through a given point with a given slope:

1. Go to LIST and enter the given point. Enter a second point that is 1 unit to the right and m units above the given point (below if m is negative), where m is the given slope.

2. Proceed in the same manner as that used to find the equation using two points.

Example 1. To find the equation of the line through (1, 1) with slope 5, enter 1 and 2 in L1 and 1 and 6 in L2.

2. Using a "friendly" window, plot these points and proceed as above with Manual Fit. The display will show 5x – 4, so the equation is y = 5x – 4.